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BARK BEETLE RESPONSE TO CLEARCUT AND SHELTERWOOD SYSTEMS IN INTERIOR ALASKA AFTER WHOLE TREE LOGGING

by

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ABSTRACT

Short-term response of bark beetles to clearcut and shelterwood silvicultural systems in interior Alaska was determined from a study of adult beetles trapped during flight. After logging, adult populations declined in clearcuts; adults increased dramatically the 1st year and declined the 2d year in the shelterwoods. The spruce beetle does not appear to be a major threat after whole tree logging under conditions of the study.

KEYWORDS: Bark beetles, Scolytidae, insect populations, shelterwood cutting method, clearcutting systems, Alaska.

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INTRODUCTION

Logging in the spruce forests of the Alaskan taiga will increase as the State's economy develops. Much of the logging will occur in areas not previously exposed to man's perturbations. The effects of logging activities on the residual stands should be considered by land managers in order to prevent unnecessary losses caused by insects.

Bark beetles are potentially the most destructive insect enemies of white spruce (*Picea glauca* (Moench) Voss) in interior Alaska. Beckwith (1972a) found 17 species of scolytids associated with white spruce in Alaska. Many of these species are secondary, attacking only dead or dying material. The spruce beetle, *Dendroctonus rufipennis* (Kirby), however, has killed white spruce over large acreages (Downing 1957, Baker and Kemperman 1974). *Ips* beetles are ubiquitous, causing losses whenever there is stand disturbance such as snow breakage, inundation, construction activity, or logging. The ambrosia beetle, *Trypodendron lineatum* (Oliv.), often increases after logging and causes reductions in grades of finished materials.

The causes of population fluctuations may vary with species, but availability of suitable breeding material is prerequisite to population increase. Many scolytids prefer recently killed or felled timber and slash to standing trees (Dyer and Chapman 1965, Dyer and Taylor 1968, Mason 1969, Sartwell 1970). Epidemic populations can arise in areas of excessive blowdown or slash accumulation after logging. Large populations of some species can successfully attack stands under physiological stress brought about by such things as overmaturity or adverse climatic conditions.

An increase in logging activity and the subsequent deposition of slash create increased breeding niches. The method of handling this material can influence future populations of bark beetles. This note reports the numerical response of bark beetles to clearcutting and shelterwood systems in interior Alaska after whole tree logging.

METHODS

The study was conducted within the silvicultural cutting areas at Bonanza Creek Experimental Forest located about 30 km (18.6 mi) southwest of Fairbanks, Alaska (Wolff and Zasada 1975) (fig. 1).

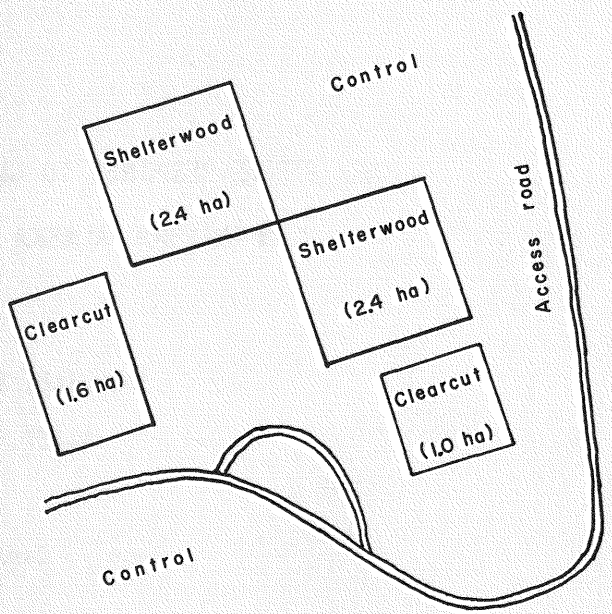

Figure 1.--Map of the cutting areas used in the bark beetle study, Bonanza Creek Experimental Forest, Alaska.

The area was logged in the fall of 1972 using whole tree logging, thus leaving little slash on the site (figs. 2 and 3). The trees were decked on site and removed in the spring of 1973. Most adult attacks could not occur until 1973, since the areas were logged after the majority of beetle flights.

Study plots were established in two clearcuts, two shelterwoods, and two uncut (control) areas so we could observe population changes after logging. Adult bark beetle flight was monitored weekly from mid-May through early September by two large window flight

Figure 2.--General view of the clearcut area after whole tree logging.

Figure 3.--General view of the shelterwood area after whole tree logging. Number of trees in the stand was reduced by 78 percent.

traps (Chapman and Kinghorn 1955). The traps were established in 1972 one full season before logging. In addition, in 1973 10 small flight traps were placed directly on fresh stumps which were located uniformly throughout the cut areas. All flight traps were placed at right angles to prevailing winds. A screen emergence trap covering 600 cm^2 (93 in^2) was placed on each of 16 stumps in one shelterwood and in one clearcut plot during the summer of 1973 after major scolytid flight (Beckwith 1972b). These traps were moved to new positions in 1974. All scolytids from each trap and cage were placed in individual labeled vials in the field and separated by species at the laboratory.

RESULTS AND DISCUSSION

The response of bark beetle activity to cutting, as indicated by adult flight, is shown in figure 4. The apparent difference in the 1972 population between the clearcut, shelterwood, and uncut areas is most likely due to trap location in relation to population source rather than actual numerical difference in population between the areas. After logging, the shelterwood areas showed a 5.5-fold increase in 1973, followed by a decline in 1974; however, the 1974 population was about three times greater than before logging. This elevated activity in 1974 resulted primarily from infestations of the ambrosia beetle and *Ips* beetles in stumps and trees damaged during logging (table 1). A total of 28 and 17 standing trees died in the shelterwood areas during 1973 and 1974, respectively, as a result of logging damage followed by secondary bark beetle infestation, primarily by *Ips*.

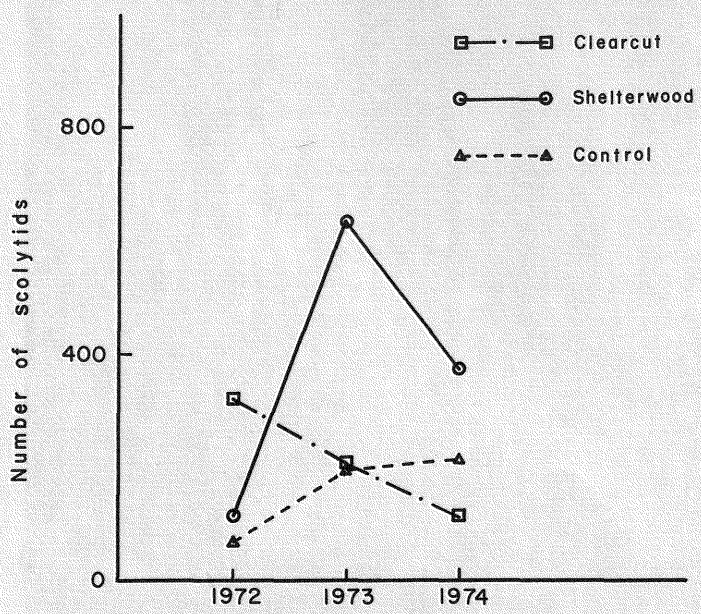

Figure 4.--Total number of scolytids from large flight traps, 1972-74. Values for 1972 are before logging; 1973 and 1974 are 1st and 2d years after logging.

A gradual decline in scolytid flight occurred in the clearcuts from 1972 to 1974. The decline could be accounted for by the removal of all the attractant source and/or changes in the microclimate to the extent that the areas were not favorable to adult flight. Also, increased solar radiation could cause a more rapid drying of the host material, making it less attractive to bark beetle infestation and/or survival. Beetle flight in control areas increased after cutting and remained approximately the same in 1974. Several large trees blew down in the control areas near the flight traps in 1973. These downed trees acted as an attractant source in 1973 and a population source in 1974. The importance of the proximity of susceptible host material to trap catch has been pointed out by other workers (Chapman and Kinghorn 1958, Hosking and Knight 1975).

Numbers of beetles caught in small flight traps located on the cut stumps followed the same general pattern as the catch in larger flight traps in 1973 and 1974 (table 1). The ambrosia beetle maintained relatively high activity in both the clearcut and shelterwood areas; however, the activity in the shelterwood was double that in the clearcut.

The weekly collections showed the same general species composition reported by Beckwith (1972b). Early

Table 1--*Scolytids collected from small flight traps 1 and 2 years after logging at Bonanza Creek Experimental Forest, Alaska*

Species	Treatment			
	Shelterwood		Clearcut	
	1973	1974	1973	1974
Dendroctonus rufipennis	166	14	39	7
Ips spp.	817	334	97	137
Trypodendron lineatum	1,976	1,889	890	711
Dryocoetes affaber	1,909	39	566	17
Polygraphus rufipennis	131	46	24	11
Miscellaneous	250	314	210	186
Total	5,249	2,636	1,826	1,069

flights in May and June represent the ambrosia beetle, the spruce beetle, and *Ips*; later summer activity is composed primarily of secondary scolytids such as *Polygraphus rufipennis* (Kby.) and *Dryocoetes affaber* (Mann.).

Emergence of bark beetles from the cut stumps was greater in the shelterwood areas than in the clearcut (table 2). Again, this difference was probably attributed to increased solar radiation in the clearcut causing warmer and drier stump conditions. *Trypodendron lineatum* was the principal emerging species, making up 93 percent and 95 percent of the 1973 total in the shelterwood and clearcut areas, respectively. The secondary bark beetle, *Dryocoetes affaber*, made up a greater percentage of the emergence from the stumps in the clearcuts in 1974. The spruce beetle was not an important component of the stump population based on the emergence cages.

Table 2--*Scolytids collected from stump emergence cages 1 and 2 years after logging at Bonanza Creek Experimental Forest, Alaska*

Species	Treatment			
	Shelterwood		Clearcut	
	1973	1974	1973	1974
Dendroctonus rufipennis	7	14	1	4
Ips spp.	28	--	2	--
Trypodendron lineatum	1,209	98	594	16
Dryocoetes affaber	55	61	19	19
Miscellaneous	7	7	10	2
Total	1,306	180	626	41

SUMMARY

Short-term response of bark beetles to the management practices and climatic conditions of the study varied with the treatment. Bark beetle populations in the clearcuts declined continuously after logging. Much of the decline could be attributed to the lack of an attractant source and to changes in the microclimate that made conditions unsuitable to population increase. The magnitude of numerical change in bark beetles was greatest in the shelterwoods, with a sharp rise after cutting followed by a decline. Most of the change was caused by an increase of ambrosia beetles in the cut stumps and the response of secondary bark beetles to stumps, logging slash, and damaged trees. Populations of the spruce beetle remained low; therefore, this species does not appear to be a major threat after whole tree logging in white spruce. The response of bark beetles in a shelterwood cutting would be expected to change with such things as age, structure, windthrow, or general climatic factors such as prolonged drought that would influence the general physiological condition of the residual trees.

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